

Removal and Recovery of Mercury from Mixed Wastes

Casimir J. Koshinski, cas@pmet-inc.com, 412-843-5000
Thomas E. Weyand, tweyand@pmet-inc.com, 412-843-5000
Pittsburgh Mineral & Environmental Technology Inc.
700 Fifth Avenue
New Brighton, PA 15066

J. Brendan McLaughlin, brendan@ccia.com, 412-843-5000
Mercury Recovery Services, Inc.
700 Fifth Avenue
New Brighton, PA 15066

Contract No.: DE-AR21-94MC31189
FETC COR Representative: Margaret Channel
September 1994 - June 1995

Abstract

This paper summarizes the results of a pilot scale demonstration project performed for the U.S. DOE. The purpose of the project was to demonstrate:

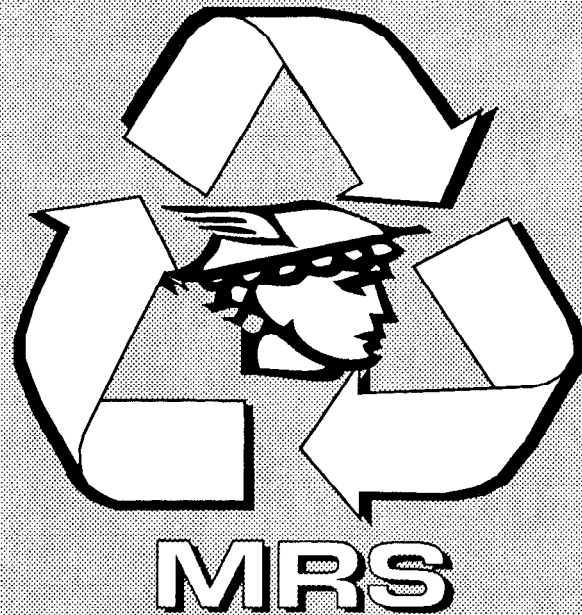
- the capability of the MRS thermal treatment technology to remove and recover mercury from typical DOE waste streams,
- determine optimum processing conditions to reduce residual mercury content to less than 1 mg/kg, and
- determine the estimated capital and operating cost for a commercial processing facility.

The objectives of the project were realized using:

- a base soil that was typical of the type found in the Lower East Fork of Poplar Creek,
- mercury added to the base soil as compounds and metallic additions, and
- NORM additions are made to simulate the low level radiation found in LEFPC sediment.

The testwork revealed that mercury could be recovered as saleable, non-radioactive metal, that radioactive elements were not carried from the soil into the gas handling system, that processed soils were less than 1 mg/kg and passed the TCLP criteria for heavy metals, and that no secondary wastes were generated during processing.

MERCURY RECOVERY SERVICES, INC.



MERCURY REMOVAL/RECOVERY PROCESS



MRS PROCESS SUMMARY

- **Proven Commercially**
 - ◆ **Mercury Removal to < 1 ppm**
 - ◆ **Recovery of 99% Pure Metallic Mercury**
 - ◆ **Recovery of Mercury from Compounds**
 - ◆ **Eliminates Sulfur & Chlorine from Effluent**
- **BDAT Designation from EPA**
- **"Recycling" Designation from States**
- **Safe, Economical, and Effective**
- **Eliminates Environmental Liability**

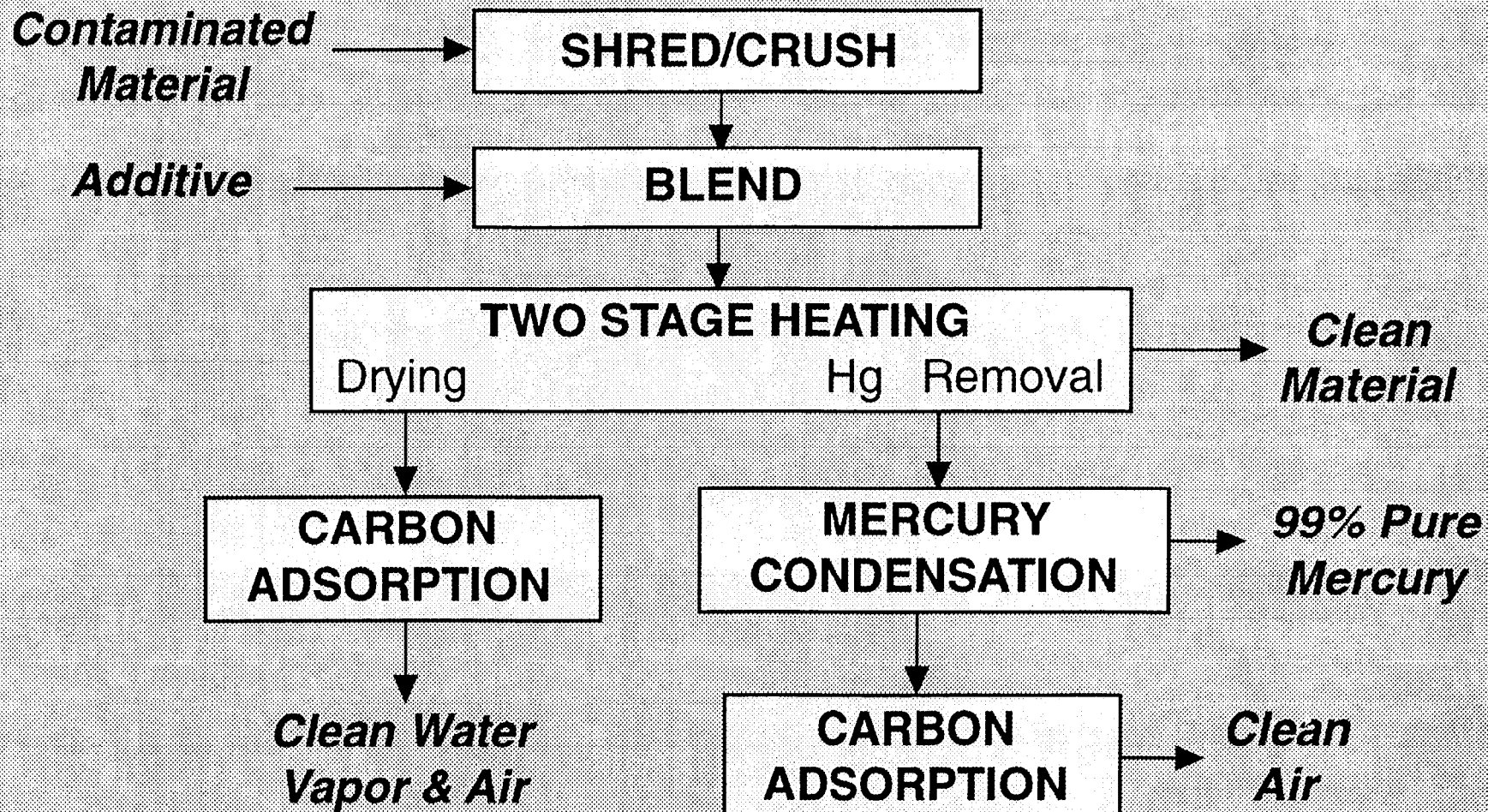


MERCURY REMOVAL FROM SULFIDE CONCENTRATES

MATERIAL	MERCURY CONCENTRATION
Concentrate Feed	50 - 400 mg/kg Hg
MRS Treated Concentrate	< 5 mg/kg Hg



MRS PROCESS FLOWSHEET





SIMULATED SOIL SAMPLE DATA

	<u>SAMPLE 1</u> Mercury ¹	<u>SAMPLE 2</u> Mercury ² Mercury Oxide ² Mercury Sulfide ²	<u>SAMPLE 3</u> Mercury ² Mercury Oxide ² Mercury Sulfide ² Mercury Chloride ²
Starting Moisture Content	5%	5%	5%
Starting Mercury Content	1,500 ppm	2,250 ppm	3,000 ppm
Final Mercury Content	<1 ppm	<1 ppm	<1 ppm
Starting Sulfur Content	N/A	0.03%	0.02%
Sulfur Retention	N/A	Yes	Yes
Starting Chlorine Content	N/A	N/A	0.03%
Chlorine Retention	N/A	N/A	Yes
1) 1,500 ppm contained mercury 2) 750 ppm contained mercury			

The above data were developed with funding through a subcontract to Pittsburgh Mineral & Environmental Technology, Inc. from the University of North Dakota Energy & Environmental Research Center under contracts with the Gas Research Institute, the U.S. Department of Energy, and Union Gas Limited.



GAS PIPELINE SOILS

<u>SOIL TYPE</u>	<u>MERCURY CONTENT</u>		<u>TCLP (mg/kg)</u>
	<u>Untreated (ppm)</u>	<u>Treated (ppm)</u>	
Sandy	15,000	→ 0.07	0.0005
Clay	900	→ 0.12	0.0008
Loam	255	→ 0.05	0.0025*
EPA Limit.....			0.2000
* Estimated based upon 100% Leaching			

** The above data were developed with funding through a subcontract to Pittsburgh Mineral & Environmental Technology, Inc. from the University of North Dakota Energy & Environmental Research Center under contracts with the Gas Research Institute, the U.S. Department of Energy, and Union Gas Limited.*



EXHAUST GAS ANALYSIS

Mercury Content

8-hour Weighted Average Reading*

< 0.003 mg/m³

OSHA Respirator Limit:

0.05 mg/m³

OSHA Respirator Ceiling:

0.10 mg/m³

**** Jerome Meter***



Average Monthly Commercial Mercury Removal Results

(Specification: 2 mg/kg)

TOTAL RESIDUAL MERCURY CONTENT			
Month	As-Received	After Treatment	TCLP
1	500-2,000 mg/kg	0.6 mg/kg	BDL*
2	500-2,000 mg/kg	0.5 mg/kg	BDL*
3	500-2,000 mg/kg	0.6 mg/kg	BDL*
4	500-2,000 mg/kg	0.7 mg/kg	BDL*
5	500-2,000 mg/kg	0.7 mg/kg	BDL*
6	500-2,000 mg/kg	1.1 mg/kg	BDL*
7	500-2,000 mg/kg	0.8 mg/kg	BDL*
8	500-2,000 mg/kg	0.6 mg/kg	BDL*
9	500-2,000 mg/kg	0.7 mg/kg	BDL*
10	500-2,000 mg/kg	0.7 mg/kg	BDL*

**** Below detection limit of 0.002 mg/l***



MATERIALS PROCESSED

- **Soils**
- **Copper Smelter Sludge**
- **Chlor-Alkali Wastes**
- **Gold/Silver Mining By-Products**
- **Gold Refining By-Products**
- **Low-Level Radioactive Mixed Waste**
- **Batteries, Activated Carbon, Catalysts, Lamps & Fluorescent Bulbs, Debris, etc.**



SOIL

- **Natural Gas Pipeline Metering Site Soils**
- **New Mexico >>> Permitted in < 6 Weeks**
- **3-Furnace, 12 Tons/Day Mobile Unit**
- **18 Months — 24 Hours/Day — 7 Days/Week**
- **6,000+ Tons Processed to < 1 ppm**
- **Recovered 2+ Tons of 99% Metallic Mercury**

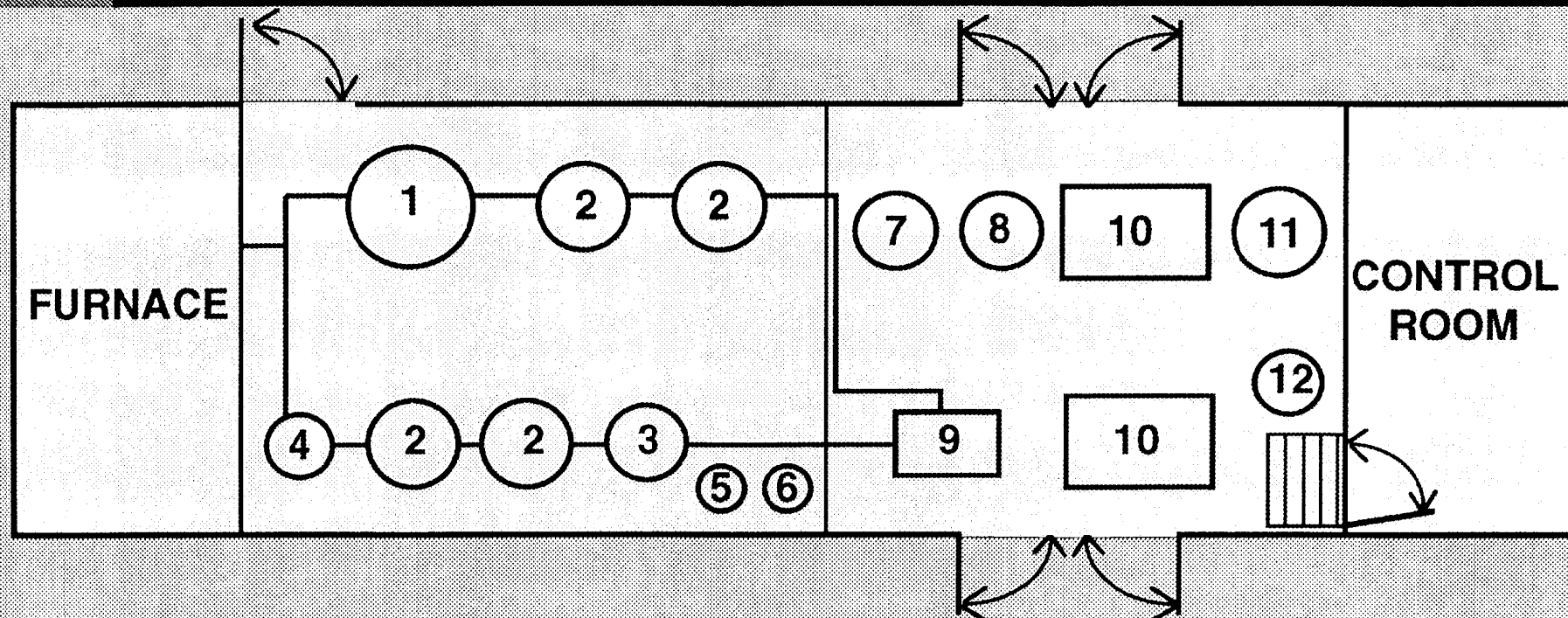


COPPER SMELTER BY-PRODUCTS

- **Industrial Resource Recovery Application**
- **Acid Plant**
 - Blowdown Sludge:**
 - 25-50% Lead**
 - 5 - 8% Copper**
 - 50 - 80 oz/ton Silver**
 - 0.2 oz/ton Gold**
 - 0.1 - 0.25% Mercury = "0" Metal Value**
- **Arizona > Permitted in < 8 weeks >>> "Recycling" Designation**
- **3-Furnace Mobile Unit @ 12 - 14 Tons/Day**
- **Processed 3,000+ Tons to Date to <10 ppm Residual Mercury**
- **Client Recovers Metal Value**



SINGLE-FURNACE INTEGRATED MOBILE UNIT



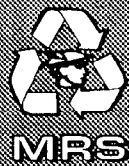
- 1 = Hg Condenser
- 2 = Hg Carbon Columns
- 3 = Auxiliary Carbon Column
- 4 = Separator
- 5 = Cooling Air Inlet Carbon
- 6 = Process Air Inlet Carbon

- 7 = Inlet Air Dehumidifier
- 8 = Coolant Expansion Tank
- 9 = Vacuum Pumps => 3
- 10 = Chillers
- 11 = Containment Carbon Filter
- 12 = Containment Blower



CHLOR-ALKALI WASTE

- **Funda Filter Material @ 20 - 60% Mercury**
- **United Kingdom >>> Permitted in 4 Months**
- **Single-Furnace, 3 - 4 Tons/Day Mobile Unit
CE Marked**
- **Start-Up December 1996**
- **Mercury Recovery:
1.2 - 1.6 Tons/Day**
- **Mercury Value Covers Processing Cost**



MERCURY RECOVERY SERVICES, INC.

- Formed 1993 as Joint Venture >>> "C" Corporation (1994)
- *Charter* To Commercialize PMET Mercury Removal/Recovery Process
- *Participants* PMET
McCarl's Process Systems (MPS)
McCarl's, Inc.
- *PMET* Environmental Technology Development
Waste Minimization & Resource Recovery
- *MPS* Environmental Engineering
Process & Equipment Design
- *McCarl's* Equipment Manufacture & Assembly
Field & Fixed Site Operations



MERCURY REMOVAL/ RECOVERY PROCESS

- **Medium-Temperature Thermal Desorption**
 - ◆ **U.S. Patent 5,300,137**
 - ◆ **Coverage in 12 Countries**
- **Reduces Total Mercury to < 1 ppm**
- **Recovers 99% Pure Metallic Mercury**
- **Produces no Liquid, Solid, or Gaseous Wastes**
- **Secondary Containment for Environmental & Worker Safety**



MRS PROCESS CAPABILITIES

- **Independent of Matrix Characteristics**
 - ◆ ***Soil:* Sandy - Clay - Loam**
 - ◆ ***Industrial Wastes:* Granular - Sludge - Agglomerate**
 - ◆ ***Debris***
- **Independent of Mercury Species**
 - ◆ **Metal - Oxide - Sulfide - Chloride - Amalgam - Organic**
- **Eliminates Sulfur & Chlorine from Exhaust**



MRS PROCESS HIGHLIGHTS

- **Modular Equipment**
- **Mobile or Fixed-Site Operation**
- **Designated "BDAT" by EPA**
- **Designated "Recycling" by State Agencies**
- **Commercial Operation Since 1994**
- **Used for Resource Recovery & Remediation**
- **Proven Capability to Handle Wide Variety of Materials**



CHLOR-ALKALI TREATMENT RESULTS

MATERIAL	ELEMENT	AS-RECEIVED	AFTER PROCESSING
Waste Water Sludge	Mercury	19,000 ppm	0.75 ppm
	Chloride	10,000 ppm	> 10,000 ppm
	Sulfur	14,000 ppm	> 14,000 ppm
D 009 Sludge	Mercury	44.5%	< 25 ppm
K 106	Mercury	1.4%	< 1 ppm



PRECIOUS METALS BY-PRODUCTS

- Resource Recovery Pilot Projects
- Smelter By-Product: *Merrill Crowe Precipitate*

Mercury	200,000 ppm \gg $<$ 10 ppm
Silver	40 - 50%
Gold	0.5 - 1%
- Refinery By-Product: *Cottrell Dust*

Mercury	72,000 ppm \gg $<$ 10 ppm
Gold	1%
Silver	1%
- Metal Value Realized & Liability Eliminated



MRS

LOW-LEVEL MIXED WASTE

- **DOE Pilot Project**
- **Model Low-Level Waste**

Poplar Creek Soil (Oak Ridge)

NORM = 4.23 pci

Mercury = 3,300 - 6,900 ppm

- **Mercury Reduced to < 2 ppm (99.97+ Removal)**
- **No RAD Carryover**



MRS EQUIPMENT SUMMARY

- **Mobile or Fixed-Site**
- **Modular and Flexible**
- **4 Tons/Day to 64 Tons/Day Configurations**
- **Low-Volume Effluent**
- **Exempt from Air Permitting ***
- **Secondary Containment for Added Safety**
- **Dependable, Low-Maintenance Operation**

**** New Mexico & Arizona***



64-TONS/DAY SITE LAYOUT

